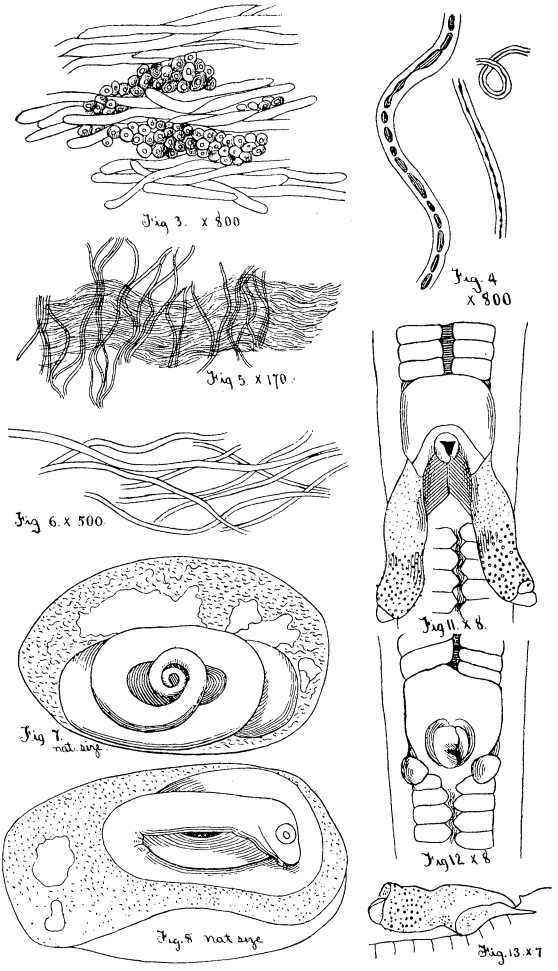
THE EGGS OF PITYOPHIS MELANOLEUCUS.

By J. Percy Moore.

In the absence of any complete published account of the breeding habits of the pine snake, the following notes may interest some of the readers of the Naturalist. The material which furnished the data for this account was collected on Aug. 3, 1892, at Formosa Bog, Cape May Co., N. J., by a party of students from the Sea Isle City Marine Laboratory, who, under the guidance of Dr. J. M. Macfarlane, were engaged in botanical investigation of the region. The nest was brought to their attention through the courtesy of Mr. Peter Hoff, one of those rare genuises of the woods whom it is the pleasure and profit of the naturalist to meet with now and then in his wanderings, and to whom our exploring parties were indebted for many kindnesses.

The snake which mothered the brood was a fine specimen of its kind, nearly six feet in length, and one of Mr. Hoff's most valued companions, for it was well-known to him as a regular habitué of his fields and barrens. At the time of oviposition, which occurred in the middle of May, Mr. Hoff saw the snake traverse the entire length (about 100 yards) of a field planted with squash and cucumber vines, pausing frequently to test the quality of the soil, which was of a loose sandy nature, with its snout. A spot was finally selected by the side of a row of plants, where the more tenacious character of the soil favored the construction of a nest. Excavation was begun by loosening the soil with the head, which was worked under the surface; and the loose earth thrown out. By alternately breaking the ground with the head, and brushing away the loosened soil with the tail, as Mr. Hoff stated, a tunnel was finally constructed of sufficient length to entirely conceal the snake. Within this tunnel it remained entirely hidden from view until oviposition was accomplished, when the entrance was closed and the locality deserted.

PLATE XIX.



Pityophis melanoleucus.

Mr. Philip P. Calvert, who was present at the excavation of the eggs, furnished me with facts relating to their position and surroundings. They occupied an enlargement of the tunnel 6–8 inches below the surface, where they were massed together in a single coherent cluster—the shells being very firmly cemented together wherever they came in contact. Ten eggs in all were found, three of which were detached from the mass in removal; the remaining seven are shown in Fig. 1 (from a sketch by Mr. v. Iterson, the laboratory artist), which I am able to reproduce here through the kindness of Dr. Ryder.

The eggs are of irregular ellipsoidal shapes, varying much in size and proportions, and exhibiting, as a result of the various pressures to which they have been subjected, irregular depressions and protuberances. In size they range from 50x37 mm. to 64x 45 mm., a long narrow egg measuring 61x35 mm., and a short broad one 60x44 mm. The average measurement of the seven is 59x41 mm., exhibiting a mean variation in length of 4 mm., and in breadth of 3 mm. The variation in size is due chiefly, if not solely, to the variable amount of yolk present.

In the hope of raising some of the young, several of the eggs were placed in a box of dampened sand and stood in a sunny spot: but on being opened after three weeks the embryos were dead, and development interrupted at the point that had been reached on Aug. 4, when I received the eggs.

When fresh, the egg-shell was flexible and elastic, and of a very tough parchment-like character; and was very tensely and firmly stretched over its contents; but after a few days' exposure to evaporation, it became somewhat loose and wrinkled.

Its structure is interesting. Externally there is a thin incrustation of calcareous matter, which impregnates only the outer layers of the matted fibres of which the shell is mainly composed, and which appears to be present chiefly in the form of minute crystals and hexagonal plates. Over the greater part of the surface the calcareous crust is minutely cracked into elongated polygonal and irregularly lozenge-shaped areas, resembling the modern "crackle-ware" or the surface of old porcelain (Fig. 2). This appearance is particularly noticeable

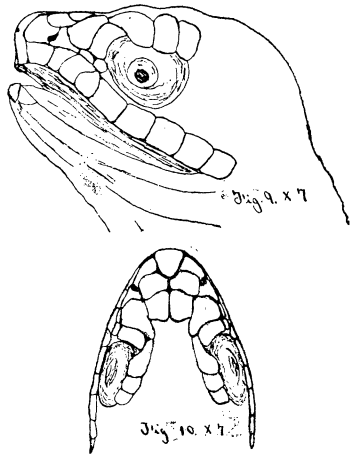
about the equator of the egg, where the long diameters of the areas are parallel to the long diameter of the egg, an arrangement due in part to a conformation of the areas to the curvatures of the surface, and in part to the structure of the fibrous shell. Calcareous deposit is most abundant at the poles of the eggs, and wherever two shells come in contact, they are firmly cemented together by the same material, all of which usually adheres as an elliptical area to one of the shells, when two thus joined are forcibly pulled apart (Fig. 1, a).

The shell is wonderfully tough for its thickness, which is only from $\frac{1}{5} - \frac{1}{6}$ mm., made up, except for the superficial deposit of mineral matter, entirely of highly elastic fibres resembling in their disposition to curl when broken, and their neutral reaction to acetic acid, the yellow elastic connective tissue fibers. These vary somewhat in thickness, the largest having a diameter of $\frac{1}{200}$ mm., the smallest of $\frac{1}{400}$ mm., and the bulk of $\frac{1}{350}$ mm. They are extremely long, and I rarely found an end not artificially made. Naturally, they seem frequently to terminate in ovoidal or cylindrical swellings which are often sharply twisted, bent or folded. Unlike those which form the shell of bird's eggs, these fibres branched but very rarely, although short filamentous processes were not infrequently seen attached along their sides. Several fibres were traced under the microscope for an inch of their lengths without a single branching being detected. Two or more fibres frequently run side by side for long distances, and separating, give rise to a deceptive appearance of branching.

The most interesting fact to be noted with regard to the structure of the fibres is that they are tubular. Most, if not all of them, possess a distinct and continuous lumen, having a diameter of from $\frac{1}{3}$ to $\frac{1}{2}$ that of the entire fibre. This structure is well-shown in cross section (Fig. 3), and perhaps even more strikingly in specimens which, after having been allowed to dry, are mounted in glycerine, when the lumen becomes very conspicuous from the chain of minute air-bubbles which fill it and mark its course as a dark beaded line (Fig. 4).

The manner in which the egg-shell is built up out of these fibres is strikingly different from what obtains in the mem-

brana putaminis of a bird's egg. Here the shell is built up of a number of distinct laminæ, in each of which the great bulk of the fibres have a generally straight and parallel direction obliquely around the egg, though their course is a regularly wavy one. They do not intricately cross and recross in every direction as in the chick's egg, but the fibres are generally disposed at angles of about 45° to the principal axis of the egg, the direction of the obliquity alternating in successive layers from one side to the other of this axis, so that fibres of successive laminæ are disposed at right angles to one another; those of alternate layers are parallel. The number of laminæ appears to be a matter of some constancy. Specimens from various parts of shells of three eggs were regularly separable into 9 or 10 distinct laminæ, which could be stripped off from the entire extent of pieces an inch square without exhibiting any signs of thinning out. I regard them, therefore, as being continuous over the entire shell. These layers are separable from one another with great ease, but it is noticeable in stripping them apart that a few fibres from one layer are always adherent to the adjacent layers, although there appears to be no extensive invasion of one layer by the fibres of another, except among the external ones. In any one lamina the sinuous course of the fibres causes a firm felting and interlocking among them (Figs. 5 and 6). The alternation of the direction of the fibres is shown in vertical section, but not very clearly, owing to the wavy courses which they take (Fig. 3).



FIGS. 9–10.
Head of Foetal Pityophis.

The optical effects resulting from this structure are striking and peculiar when the entire series of separated layers are

placed side by side in corresponding positions on a moistened slide. Those pieces in which the fibres are disposed at right angles to the rays of light coming in from a window appear, to an eye placed at the proper angle to catch the reflected light, of a beautiful, glistening, satiny white; while those the fibres of which lie parallel to the same rays, and present no reflecting surfaces, appear dull and lustreless. These appearances can be instantly changed from one set to another on revolving the slide over an angular distance of 90.°

A place of natural division, where separation is more readily effected than elsewhere occurs between the 3d and 4th inner layers. The three innermost ones then appear to constitute together the membrana putaminis. There is apparently no disposition toward the formation of a lenticular air-space; this being prevented by the high elasticity of the membranous shell, which causes it to continually contract over the contents as they shrink through evaporation. This contractility appears, however, to be limited, as noted above. Perhaps it is an adaptation to the varying conditions of moisture and drought to which these eggs, and others of their kind, are subjected.

The external six or seven layers are more closely bound together, and constitute the shell proper. The depressions in the surface of one layer resulting from the wavy course of the fibres, accommodate elevations on the surface of adjacent ones, thus greatly increasing the strength of the shell and making possible that partial invasion of one layer by the fibres of adjacent ones which is mentioned above, and which becomes more marked externally. These binding fibres may be seen to stretch and break as two layers are torn asunder.

The wavy structure also produces on the surface beneath the calcareous crust, and especially where two shells have been united, a peculiar pebbled appearance, like the pebbled binding of books. The outer layers in which the calcareous matter is deposited, have a less regular structure—the fibres being more irregularly interwoven; but when the mineral matter is removed with acid, the fibres readily disentangle and separate, being bound by no other cementing substance. Cement sub-

stance appears to be absent also from the other layers; which may be easily teased up, when the fibres float off freely in the mounting medium.

A rough analysis of the shell gives the following results.

Water	29·5 per cent.
Soluble mineral matter (almost entirely calcium carbonate)	16·6 per cent.
Organic matter	53·7 per cent.
	99·8

Well advanced embryos were found within the eggs. These must have been at least 10 or 11 weeks old. Those examined numbered equally males and females. They have an average length of $6\frac{3}{4}$ inches, the tail being $1\frac{1}{16}$ inches in a male and slightly less in a female specimen.

The embryos lie deeply embedded on one side of the abundant yolk, which envelops, and almost completely surrounds them, being packed thoroughly in among the folds; and in alcoholic specimens, requiring to be largely cut away to expose the full length of the embryo. The young snakes are arranged in somewhat irregular spiral coils, the larger folds of which are directed in the long diameter of the egg. There is no regularity in the arrangement of the folds; the spiral being sometimes wound in a left-handed, sometimes in a right-handed direction, figs. 7 and 8. Large clear albuminous masses are frequently embedded in the yolk.

The umbilical cord is short, measuring about $\frac{5}{8}$ inch in length and $\frac{3}{32}$ inch in diameter. It leaves the body anywhere between $\frac{1}{2}$ and 1 inch in front of the vent, between which points the somatic folds are entirely free from one another, while for a distance of an inch to an inch and one-half anterior to the umbilical cord they are only very feebly united. Beyond this point the gastrosteges are complete. These number in all 216 in one ♀ specimen examined—a number slightly less than the adult possesses. The anal plate is single, and the number of scales in a vertical row normal.

On the head the absence of certain plates present in the adult is noticeable. The scutes have not yet developed over

the roof of the prominent brain case, nor in the post-ocular region. The frontal and parietal plates are not indicated at all, and the developed plates show some curious differences from the adult condition. The supraocular is clearly divided by two transverse grooves into three scutes, of which the anterior is largest. I suspect that the others may be really post-oculars which are here displaced by the prominent eyes. A small scute which may unite with the loreal underlies the preocular. Four postfrontals are present, the external pair being much the larger; but the single pair of prefrontals shows no indication of a division. The superior labials number 9, one more than in a specimen of the adult which I have compared. The inferior labials, except the first, are not developed, but the mental is well marked. The description of the head scutes is made from a single specimen, the only one which was well enough preserved to show them satisfactorily; figs. 9 and 10.

The egg tooth is indicated by a narrow fold which arises just below the ventral margin of the rostral scute. Rows of small papillæ on the jaws and palate represent the developing teeth. Their number and position are as in the adult.

In all male examples the paired penes were fully extruded immediately behind the anal plate; rudimentary penes were present in the females as a pair of low conical elevations in corresponding positions, fig. 12. In well preserved specimens each hemipenis is a somewhat compressed organ attached by a narrowed base. A constriction about the middle separates a basal from a somewhat more swollen terminal portion, which ends in a pair of rounded lobes, of which the dorsal is the larger and arises from a thickened rim which is seen to become continuous below with the more ventral lobe. On the external side of each hemipenis is a rather prominent lateral lobe.

Proximad to the median constriction the surface is dotted with numerous fine pointed projections, while the distal portion is covered by larger smoothly rounded papillæ. No papillæ whatever are present on the dorsal terminal lobe, which is quite smooth. Figs. 11–13.

Explanation of Plates XIX, XX.

Pityophis melanoleucus.

Fig. 1—Cluster of seven eggs represented as they naturally cohere. a—point at which an eighth egg was attached. Natural size.

Fig. 2—Surface cracking of the calcareous crust—from an equatorial region. x 10.

Fig. 3—Vertical section of a small portion of the egg shell showing a small part of five laminæ. x 800.

Fig. 4—Several fibres of different sizes after being dried and mounted in glycerin. The lumens are filled with air. x 800.

Fig. 5—Surface view of a small portion of a lamina x 170.

Fig. 6—A few isolated fibres x 500.

Fig. 7–8—Two views of embryos in their natural positions on the yolk. Natural size.

Fig. 9—Left side of head of an embryo showing the scutes. x 7; p. 881.

Fig. 10—Dorsal view of the same x 7; p. 881.

Fig. 11—Anal plate and penes of a male x 8.

Fig. 12—Same region of a female. a—rudimentary penes. x 8.

Fig. 13—Lateral (external) view of a hemipenis x 7.

PLATE XX.

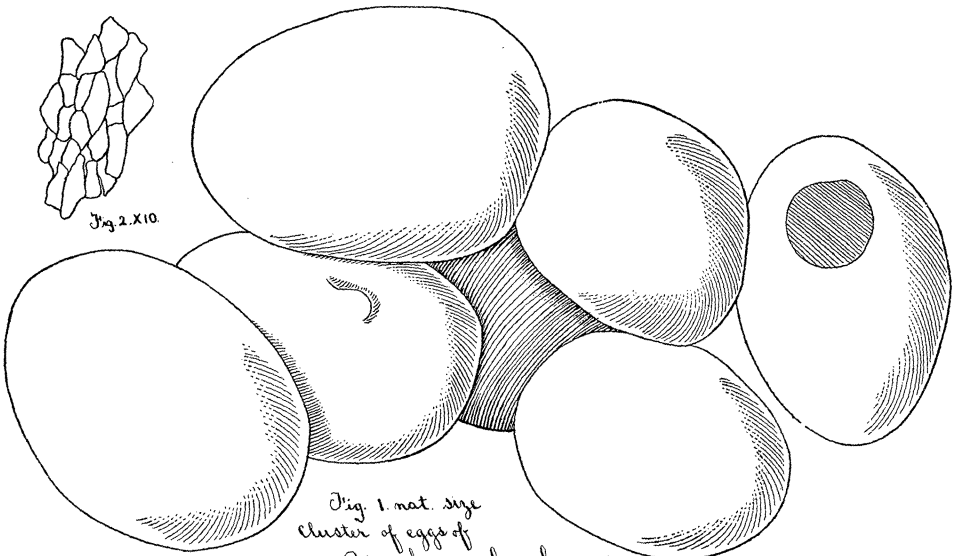


Fig. 2. X10.
Fig. 1. nat. size
cluster of eggs of
Pituophis melanoleucus